

Bryozoa or *Moss Corals*.—These creatures occupy a higher position in the organic scale than the simpler-formed polypes with which they were formerly associated. Many hundreds of microscopic fossil species have been discovered within the last few years. The shells, or outer tunics, enter into the composition of chalk beds, compact limestone, and sea sand, as well as the sands of the deserts. These fossil forms, many species of which are still living, are mostly microscopic; those which are visible resemble minute grains. Those which at present engage our attention belong to the genus *Celaria*, and, I am of opinion, are closely allied to *C. Loricata*.

A second species of *Bryozoa*, which, however, I am unable to distinguish, also occurs in company with those mentioned. This variety forms rounded columns, about an eighth of an inch in length, with fine ribs or threads passing longitudinally downwards.

The few forms which I have been able to detect in the specimens forwarded to me lead me to the conclusion, that the strata in which they occur belong either to the uppermost cambrian or to the lowest silurian formation. It is highly remarkable that these rocks are found in an auriferous locality, and in the immediate vicinity of our earliest gold-field.

I may beg to observe, that fossil remains of the oldest Neptunic era may be obtained in abundance at certain spots in an extensive line of district eastward of Melbourne, and which would well repay the trouble of the enterprising man who would institute a search for them.

Subsequently to writing the above, I have discovered by a minute examination, in the rocks referred to, the forms exhibited in the plate. The palæontological description of these will form the subject of another paper.

ART. XVIII.—*Practical Remarks on Hydrometry.* By
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THE contradictory results of the hydrometrical observations made by different persons in this colony, had induced me, some weeks ago, to give notice of my intention to submit to this society a paper embodying my objections to the mode of guaging streams often adopted by the engineering profession, and the result of my own experience in these operations.

Recent domestic afflictions had, however, caused me totally

to forget my previously expressed intention of contributing such a paper; so that, having ascertained, at the last moment, that the paper was announced for this meeting, I must crave the indulgence of the members now present for submitting to them the following cursory and hastily written remarks.

As questions of moment, in reference to water-power or supply, are often dependent upon the accuracy with which steam gaugings are conducted, I have been surprised at the unsatisfactory manner in which experienced engineers have frequently, in Great Britain, performed the simple operation of measuring the discharge of a stream or river.

Little discrimination, for instance, has been displayed in the selection of the site for determining the sectional area of a stream, notwithstanding that the surface velocity was derived from observations on a float; yet, when a float was employed, no near approach to accuracy could be attained, unless not only the sectional areas but also the cross profiles, differed so little within the longitudinal limits assigned to the observations on the float as to have caused the stream to approximate closely thereabouts to that condition aptly termed by French writers "*Régime uniforme.*" The size, and sometimes even the specific gravity of the float have also been considered of immaterial importance, and the mean velocity has been almost universally deduced from Dubuat's Formula, which makes, when expressed in inches, the bottom velocity equal to the square of the difference between the square root of the surface velocity and unity, and the mean velocity equal to half the sum of this bottom velocity and the surface velocity.

I protest against the employment of this formula, which, when applied to very small or very great surface velocities, is productive of grave errors.

I am, however, aware, that this formula of Dubuat's (originally promulgated near the close of the last century), has been adopted without question as to its accuracy in various standard English publications; for instance, the hydrometrical table contained in the last edition of the *Encyclopædia Britannica* is based thereupon, also, the table in Stevenson's *Hydrometry*, as well as those given in several engineering manuals. But on the continent of Europe, where the hydraulic investigations since the publication of Dubuat's "*Principes d'Hydrauliques*" have been most extensively and accurately conducted, on profound scientific principles, Dubuat's formula has been superseded by more accurate although less simple rules.

There is little doubt but that Dubuat, with that yearning for mathematical generalisations so characteristic of the French philosophers, must, to a certain extent, have ignored the results of experiment, in order to obtain the neat expression in the formula in question.

De Prony's Rule, as expressed in metres, is

$$x = \left(\frac{2.372 + v}{3.153 + v} \right);$$

or,

$$\left(\frac{7.71 + v}{10.25 + v} \right) v, \text{ when expressed in English feet.}$$

It is far more accurate that Dubuat's, having been tested by an immense number of observations, made not only in small artificial channels, but also on the largest and deepest European rivers, with the aid of tachometers adapted for the correct registration of velocities, at any depths below the surface.

For a surface velocity of fifteen English inches per second, De Prony's rule gives the same *mean* velocity as Dubuat's formula; but for surface velocities much less or much greater than fifteen inches per second, the diversity between the results is very great.

For example, I will suppose that the observed surface velocity of a stream is one inch per second. Then we should have,

Corresponding mean velocity	{ According to Dubuat's formula, applied to English inches, }	0.50 inches.
Ditto	ditto According to De Prony, .	0.75 inches.

If, therefore, the sectional area of the imaginary stream be such, that when multiplied by the mean velocity, as determined from Dubuat's formula, it would represent a water supply for 100,000 persons, the more correct mean velocity, according to De Prony, would represent a water supply for 150,000 persons! Whilst De Prony's formula thus gives greater comparative mean velocities than Dubuat's, for surface velocities less than fifteen inches per second, it gives less mean velocities than Dubuat's for surface velocities exceeding fifteen inches per second.

The ratio of the mean velocity to the surface velocity being mainly influenced by the rate of such velocity, and being altogether independent of the depth or sectional area, I cannot but think that tabulated quantities, for practical

use, might have originally been more readily derived from the actual experiments than from empirical formulæ.

Some years ago I computed for English inches, for my own use, the following short table of ratios between surface and mean velocities, and which ratios give results conformable to De Prony's Rule.

Surface Velocities in Inches.			Multipliers for Mean Velocities.	
1	to	3	...	0.75
3	to	8	...	0.76
8	to	13	...	0.77
13	to	18	...	0.78
18	to	25	...	0.79
25	to	35	...	0.80
35	to	45	...	0.81
45	to	55	...	0.82
55	to	65	...	0.83
65	to	76	...	0.84
76	to	87	...	0.85
87	to	100	...	0.86

When I have employed a float for determining surface velocities, I have taken the following precautions to ensure due accuracy. Having chosen for the measurement of the discharge, a site where the apparent regularity of the width of the stream, and general aspect of its banks, led me to suppose that no very material variation of the cross profiles of the bed of the stream would occur for a distance of fifty feet, I then departed from the usual mode of procedure inasmuch as I took *eight* or *ten* cross sections within the longitudinal extent of fifty feet.

If these cross sections and corresponding sectional areas did not differ to any great extent, they afforded a proof that the site was favourable for the correct determination of the discharge of the stream. The mean of the sectional areas was then taken as the mean transverse sectional area, corresponding to the assumed longitudinal distance of fifty feet, which distance was defined by parallel transverse lines perpendicular to the axis of stream, and indicated on the banks of the stream by ranging rods.

Bearing in mind the fact that a large floating body, through not participating in the irregular intimate motion of the particles of water of a running stream, would move with somewhat greater velocity than a minute fragment of the same body, I employed a very small float, consisting of a very diminutive vial, so weighted with sand as to cause it to float along when corked, with the top of the cork flush with the surface of the water.

The float was then thrown into the main thread of the stream, a few yards above the upper line, and the number of seconds observed to elapse in its passage from the upper to the lower line. The number of seconds consumed in this passage was observed about a dozen times, and that observation which gave the least number of seconds was obviously adopted as the most correct. With this number of seconds, the distance of fifty feet, and the table, the mean velocity corresponding to the portion of stream under examination was computed.

Then this mean velocity, multiplied by the *mean sectional area of the stream within the specified limits*, gave the discharge of the stream much more accurately than if one cross section only had been measured.

If the observer be provided with Brunning's, Woltman's, or any other accurate tachometer, then Mr. Stevenson's mode of determining the discharge of a river, by subdividing the cross section into a number of trapezoids, and determining the mean velocities for each of them as multipliers for the corresponding areas thereof, is a very correct one. I have followed this method when I formerly had occasion to determine the quantities of water that passed to, and through, opposite a town on a tidal estuary, during the flow and ebb of a tide that rose and fell a certain number of feet and inches at a tide-gauge. I tried Pitot's tube during the operation, but found it unsatisfactory for great velocities; also the hydrometrical pendulum, which was not adapted for determining the great variations that occurred in the surface velocity; for when the ball of the latter instrument worked well for moderate velocities, it proved quite unmanageable for high velocities, whilst for low velocities it showed no appreciable deflexion from the vertical. I subsequently constructed a hydrometrical pendulum, furnished with four balls of gradually increasing specific gravity, so that whilst the lightest ball was very sensible to the influence of very small surface velocities, the heaviest was not too violently acted upon by the highest velocities that occurred in ordinary rivers.

The co-efficients for each ball were respectively determined by direct experiment; and the numbers affixed to the balls and corresponding coefficients were registered on the instrument.

Then, in the measurement of the surface velocity of a stream, that ball was employed which proved on trial to be the best adapted for the measurement of such velocity, by

causing the thread attached to the ball to form with the vertical an angle of from twenty to thirty degrees.

Denoting by θ the coefficient corresponding to that ball, and by δ the observed angle, the surface velocity was found by the ordinary formula $X = \theta \sqrt{\delta}$.

I have known cases where engineers, with a mere knowledge of the fall per mile in a river, and the sectional area, taken at one point only, have, from such very insufficient data, endeavoured to compute the discharge. For the usual formula, by Eytelwein, from which have been derived the tabulated quantities in Beardmore's Hydraulic Tables, and other works, is only applicable under the following conditions, which never occur unless in carefully constructed artificial channels: viz.

Unchanging sectional area.

Unchanging wetted perimeter.

If on the length corresponding to the fall, a great number of cross sections had been taken, so as to admit of a *mean sectional area*, and *mean perimeter of the water contour* being deduced therefrom, then of course a rough approximation to the discharge could have been computed.

Many instances might be cited of disappointment attendant on the completion of hydraulic works, owing to the preliminary calculations having been made on erroneous principles. For instance, when the works for conducting water into Edinburgh were completed, the quantity of water delivered was only one-sixth of the quantity estimated by the designer of the work, although he himself acknowledged that the work had been executed in strict accordance with his plans.

ART. XIX.—*On the Primary Upheaval of the Land round Melbourne, and the recent Origin of the Gypsum or Sulphate of Lime in the great swamp between Batman's and Emerald Hills, Flemington, Williamstown, and Melbourne, illustrated by a large number of Specimens from that Locality.*
By WILLIAM BLANDOWSKI, ESQ.

THE land which now constitutes the colony of Victoria owes its origin to the same mighty convulsion which upheaved the Australian Alps. Beginning where those mountains cross the latitude of 37° , eruption followed eruption in rapid succession, the plutonic agency constantly advancing westward,